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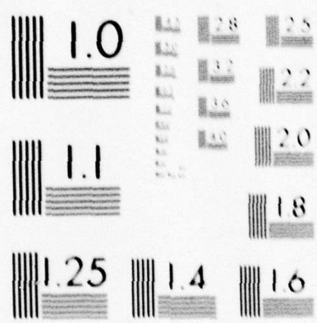

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LEVEL II

AMPHIBIOUS ENGINEERED OPERATING CYCLE (PEOC) PROGRAM INITIATION STUDY REPORT VOLUME I EXECUTIVE SUMMARY

June 1978

Prepared for
DIRECTOR, AMPHIBIOUS AND COMBAT SUPPORT
SHIP LOGISTIC DIVISION
NAVAL SEA SYSTEMS COMMAND
WASHINGTON, D.C.
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This report describes the research and engineering effort performed by ARINC Research Corporation during an Amphibious Engineered Operating Cycle (PEOC) Program Initiation Study for the LST-1179, LPD-4, and LHA-1 Class ships. It describes the appraoch, findings, and conclusions of the study. The alternative PEOC maintenance strategies for these classes are described and evaluated for both effectiveness and resource requirements. Additionally, detailed planning and engineering requirements required to develop

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PROGRAM INITIATION STUDY REPORT

VOLUME I
EXECUTIVE SUMMARY

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a Subsidiary of Aeronautical Radio, Inc.
2551 Riva Road
Annapolis, Maryland 21401

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ABSTRACT

This report describes the research and engineering effort performed by ARINC Research Corporation during an Amphibious Engineered Operating Cycle (PEOC) Program Initiation Study for the LST-1179, LPD-4, and LHA-1 Class ships. It describes the approach, findings, and conclusions of the study. The alternative PEOC maintenance strategies for these classes are described and evaluated for both effectiveness and resource requirements. Additionally, detailed planning and engineering requirements necessary to develop and implement the program are described, and a Plan of Action and Milestones for the program is provided.

The results of this study are presented in two volumes: Volume I - Executive Summary and Volume II - Study Report.

CONTENTS

SECTION ONE

INTRODUCTION

1.1 BACKGROUND

In 1973 various ship material inspections and reports indicated that despite increasing maintenance costs, the material condition of many ships of the fleet was below acceptable standards and generally unsatisfactory. This situation clearly demonstrated the need to develop a comprehensive program aimed at achieving an early improvement of the Fleet's material condition. As a result, the Chief of Naval Operations (CNO) initiated an objective (CNO Objective #3) to improve the material condition of ships. In response to this objective, in 1977 the Chief of Naval Material (CNM) directed the establishment of the Ship Support Improvement Project (PMS 306) with a number of interrelated efforts designed to contribute to the formulation of new and more efficient maintenance strategies for Naval ships. The Ship Support Improvement Project has initiated three basic courses of action. These are (1) a Maintenance System Development Program to make the necessary changes to the Navy maintenance system to foster improved fleet readiness; (2) an Intermediate Maintenance Activity Upgrade Program to provide for increased intermediate maintenance level capability and capacity; and (3) the Engineered Operating Cycle (EOC) Program to establish a structured engineered approach for maintaining ships of selected classes. The establishment of the Amphibious Engineered Operating Cycle (PEOC) Program, initially for the LHA-1, LST-1179, and LPD-4 classes of ships, would be part of the third effort.

1.2 ENGINEERED OPERATING CYCLE PROGRAM STRUCTURE

A typical surface-ship EOC program consists of a one-year Initiation Phase, a two-year Development Phase for each ship class, and an Implementation Phase that extends through the remaining life of the ship classes involved. New EOC programs are envisioned to be structured along these lines, patterned after already established EOC programs, with exceptions expected to accommodate the special requirements of the new classes of ships.

The objective of each program phase is attained through an engineered, analytical process. During the Initiation Phase, ship data are collected objectives and constraints,that will guide the EOC program, are defined. The current status of the ship's material condition and maintenance

strategy are assessed. Alternative maintenance strategies are identified, and from them the preliminary EOC maintenance strategy is defined. The existing and proposed maintenance strategies are compared and analyzed, and the feasibility of adopting an EOC Program is evaluated.

During the Development Phase, detailed engineering efforts go into a thorough development and evaluation of the specifics of the approved EOC maintenance strategy. Pertinent detailed technical, operational, and experience data are assembled and from those data, critical equipments and systems are selected, beneficial technical and Fleet Modernization Program (FMP) alterations are identified, and maintenance requirements for pre-EOC overhauls are developed. Detailed systems engineering analyses are performed on selected critical equipments, with specific restorative and corrective maintenance requirements identified in the development of the class maintenance and modernization plans. Standards of material condition assessment and program effectiveness are developed to permit the analysis of the effectiveness of the EOC Program and to modify the efforts as necessary. The EOC Management Plan provides guidance in program administration, planning, execution, and support. Together, these elements constitute the EOC Plan that is implemented in the Implementation Phase.

During the Implementation Phase, each ship will be given a pre-EOC overhaul (if required) before entering its Engineered Operating Cycle. EOC support elements and organizations, including the Central Technical Group and Site Teams, will be formally established to continue the coordination and integration of the EOC Program with existing maintenance programs. The program will be continually analyzed on the basis of feedback received from material condition assessments and post-overhaul, trend, and program-effectiveness analyses. The results of these analyses will be used to support the management of the program and show where modification is required.

1.3 The PEOC PROGRAM

The PEOC Program is a proposed new EOC program whose purpose is a realignment of ship maintenance strategy designed to improve the material condition of designated amphibious ships. Its objective is to maintain combat readiness for ships in the program at an acceptable cost while maintaining or increasing their peacetime operational availability. Initially LHA-1, LST-1179, and LPD-4 classes have been identified for the PEOC Program. A basic element of the Program will be the establishment of engineered maintenance and modernization plans for each of the designated classes. These class plans identify anticipated maintenance tasks and their frequencies. Class maintenance and modernization plans are used to forecast and assist in scheduling projected maintenance burdens on Fleet resources. The PEOC Program will provide improved planning and engineering tools to effect better maintenance management, including the optimization of ship operating cycles.

The analysis conducted in the Initiation Phase included principal logic and functional elements of reliability-centered maintenance methodology. Maintenance experience and material condition were assessed, considering mission criticality and resource costs, and then used to review and select appropriate alternative maintenance strategies. Similarly, in the Development and Implementation Phases these same considerations will be used to define and document maintenance requirements for the selected critical equipments and systems. The consistent use of this methodology helps provide assurance that the most essential and cost-effective class maintenance strategy revisions will be accomplished.

SECTION TWO

STUDY APPROACH

2.1 OBJECTIVE OF THE STUDY

The objective of the PEOC Program Initiation Study, the principal effort of the Program's Initiation Phase, is to determine if a revised maintenance strategy could achieve the primary goal of the PEOC Program. That goal is to develop a long-range maintenance strategy designed to effect an early improvement in the material condition of designated amphibious ships, then maintain their combat readiness at an acceptable cost while maintaining or increasing their peacetime operational availability. The LHA-1, LST-1179, and LPD-4 classes were designated for induction into the PEOC Program and were investigated in this study.

2.2 STUDY APPROACH

The approach used for the Initiation Study was adpated from the EOC Development Manual (draft), February 1978. It addressed the feasibility of adopting a PEOC Program maintenance strategy that is cost-effective and within the objectives of the program. Operational, maintenance, and financial data from diverse sources were analyzed to determine current class maintenance strategies and material condition and to structure proposed PEOC Program class maintenance strategies. The strategies selected which took into account fleet operational and Fleet Modernization Program requirements, were designed to improve class material condition. Effectiveness and resource requirements were then calculated for both the current and PEOC Program strategies.

Measured and projected class material condition, effectiveness, and resource requirements were comparatively analyzed for both current and PEOC maintenance strategies, and conclusions were drawn relative to the benefits of implementing the PEOC Program. Planning and engineering requirements to develop the program were identified, with associated budgetary estimates, and a Plan of Action and Milestones was formulated. Finally, the conclusions of the Initiation Study were developed, together with recommendations concerning program implementation.

SECTION THREE

RESULTS

3.1 CURRENT SHIP STATUS ASSESSMENT

3.1.1 Current Ship Maintenance Strategies

Maintenance strategies, as such, are seldom sufficiently defined and documented to permit quantitative specifications of the amount of maintenance to be performed at each level of repair (LOR) by each method of repair (MOR) or on the basis of each timing of repair (TOR) for individual ship classes. Instead, information on maintenance strategies must be collected and correlated from various Navy sources - maintenance data files, class maintenance managers, fleet operational records, provisioning documentation, etc. This was the method used to determine the maintenance strategies for the LST-1179 and LPD-4 classes. Inspection of maintenance histories and data, compilation of operational assignments, review of provisioning technical documentation, and discussions with the NAVSEA Ship Logistic Division and PERA (ASC) personnel all confirm that the majority of the maintenance during the operating cycle is performed at the organizational level, utilizing piece-part replacement on a periodic basis. Except for some electronic equipment, very little modular/subassembly replacement has been performed. No rotable pool replacement program has been in effect except for special "turn-around" programs (such as those for gun sights, communication antennas, etc.).

The current maintenance strategy for the LHA-1 class, like that for the LST-1179 and LPD-4 classes, is not well defined and documented, although the shipbuilder's designed maintenance strategy is well documented. In addition to the information from maintenance histories and data, provisioning technical documentation, and NAVSEA Ship Logistic Division and PERA (ASC) personnel, the LHA Plans For Maintenance (PFMs) were reviewed to provide insight into the planned maintenance strategy. These documents, developed during ship construction, analyze the maintenance requirements for most of the ship's mission-critical equipment and assign the LOR, MOR, and TOR for each. These various information sources confirm that the majority of the maintenance during the operating cycle is performed at the organizational level, utilizing piece-part replacement on a periodic basis. Very little modular or subassembly replacement is performed except on some electronic equipment. No rotable pool replacements have been specified nor anticipated except for special "turn-around" programs.

3.1.2 Current Ship Material Condition

An important aspect of this study is the assessment of present ship material condition achieved by using the current ship maintenance strategy. A good measure of the success of a maintenance strategy is the resulting material condition of the ship's equipment and systems. Material condition was determined through analysis of suitable material condition indicators. Three measures of material condition were defined and used:

- Maintenance Data System (MDS) Factor - A Maintenance Data System Factor summarizes the following indicators of material condition:
  - Ship's Force parts dollars
  - Ship's Force man-hours
  - Intermediate Maintenance Activity man-hours
  - Number of Ship's Force labor transactions
- Material Condition Readiness Index (MCRI) Factor - This factor provides an indicator of the severity of failures by EIC. The MCRI is published in the CASREP Material Condition Index Report. This index is a mathematical product of three indicators that have a bearing on the degree of unreadiness of ships experiencing casualties.
- Additional Maintenance Factors - For the LST-1179 and LPD-4 classes, a third indicator of material condition by EIC is the amount of depot maintenance required during the regular overhauls at the end of each operating cycle. The depot level maintenance man-hours were extracted from ROH SARPs provided by PERA (ASC) and averaged by EIC.

  For the LHA-1 Class, a third indicator of material condition was provided by the Negative Man-Hour Differential (NMHD). The NMHD is the excess of Ship's Force and IMA man-hours expended on a system above design data projected values, and was used to evaluate the accuracy of the projected design values. This indicator was used to ensure that off-ship as well as shipboard maintenance was adequately considered in the identification of maintenance-critical systems.

3.1.2.1 LST-1179 Class Material Condition

The LST-1179 Class MDS data were analyzed to assess the class material condition resulting from use of the current maintenance strategy. Some 283 EICs were identified as exceeding one or more of the MDS Factor Indicator Thresholds and, therefore, requiring further analysis. In a similar manner, the MCRI Factors for the various EICs were analyzed, and the third indicator of material condition, the amount of depot level maintenance - by EIC- during the ROH, was analyzed.

LST-1179 Class material condition was evaluated from a review of all material condition indicators, INSURV results and comments, the Class Corrective Action Plan, and consideration of the age of the ships. The high consistency in the results of the material condition indicators provides increased confidence in conclusions based on their use. Table 3-1 ranks the most maintenance-critical EICs for the LST-1179 Class.

Analysis of the data for the class showed approximately 8 percent of the EICs exceeded one or more significance thresholds. Although all of these EICs experienced a maintenance burden of some significance, the greatest concentration of material condition degradation occurs for those few EICs identified as maintenance-critical. While the overall class material condition appears satisfactory from a review of this recorded data, these maintenance-critical EICs significantly affect the mission performance ability of these ships and show a need for attention and corrective action.

3.1.2.2 LPD-4 Class Material Condition

LPD-4 Class material condition was evaluated in the same manner as was that of the LST-1179 Class. Material condition indicator results showed good consistency and recorded only slightly degraded material condition for the great majority of the more than 4100 class EICs. Table 3-1 ranks the most maintenance-critical EICs for the LPD-4 Class.

Analysis of the data for the LPD-4 Class showed that approximately 8 percent of the EICs exceeded one or more significance thresholds. Although all of these EICs experienced a maintenance burden of some significance, the greatest concentration of material condition degradation occurs for those few EICs identified as maintenance-critical. While the overall class material condition appears satisfactory from a review of data, maintenance-critical EICs significantly affect the ability of these ships to perform their missions and show a need for maintenance attention. A review of the class modernization plans indicates that a number of alterations have been developed to solve some of the major maintenance problems. However, none of the critical EIC equipments is scheduled for replacement or for major configuration change.

3.1.2.3 LHA-1 Class Material Condition

The LHA-1 Class, with a limited amount of historical data available and a good quantity of design data, presented an opportunity to compare and update design values with empirical data. The design data were documented in the shipbuilder's Plans For Maintenance (PFMs). The PFMs identify the amount of corrective maintenance that can be anticipated for each specific system on the basis of an analysis of the probable equipment failures, their frequency, and Mean Time to Repair (MTTR), as identified in the Maintenance Engineering Analyses (MEAs) that make up each PFM. A PFM usually contains information on more than one EIC and, similarly, several PFMs may apply to each EIC.

Table 3-1. RANKING OF CLASS MAINTENANCE-CRITICAL EQUIPMENTS

LST-1179 Class

EIC	Nomenclature
B101	Engine Diesel
3101	Generator set, 60-Hz, diesel driven
AD04	Ramps
T104	Boiler, auxiliary (accessories and controls)
TF03	Intermediate and low pressure air systems
T801	Firemain
B408	Propellers, controllable pitch and controls
TM01	Winches and hoisting equipment, miscellaneous
Y403	Craft, landing - vehicle personnel (LCVP Mk 7)
QD4A	AN/VRC-46, radio set
P118	AN/SPS-10F, radar set

LPD-4 Class

EIC	Nomenclature
F101	Boiler, D/express/header-type, propulsion system
F303	Pump unit, centrifugal (multistage, turbine-driven) main feed
T801	Firemain
TK03	Distilling plant, low pressure, flash type
QD3R	AN/SRC-20, Radio set
GBL2	Mount, 3" 50 cal. twin RF Mk 33 Mod 0
310C	Generator set, 60-Hz, steam turbine driven
F401	Blower group, air supply system, combustion, main propulsion
T404	Air conditioning system, chilled water (R-12)
FE03	Shaft, main propulsion
T605	Fueling service, transfer and blending system, aviation JP-5/HEAF
TH03	Auxiliary steam supply system

LHA-1 Class

PFM	Nomenclature
36	Radio communications and ITAWDS
28	Aircraft handling and assault systems
17	Ballast and salt water systems
35	Surveillance systems and waveguides
32	Gunfire control
34	Guided missile fire control
23	Deck equipment
20	Compressed air and gas
13	DC monitoring Intercommuncations systems Interior voice communications
24	Hull and Hull fittings

In a similar manner, the MCRI Factors for the various shipboard systems were analyzed. The third indicator of material condition, ROH information, could not be analyzed for the LHA-1 Class because no LHA ship has yet been overhauled. Instead, a different indicator, the Negative Man-Hour Differential (NMHD) (defined as that number of man-hours expended on a system in excess of the PFM projections) was analyzed. Table 3-1 ranks the most maintenance-critical PFMs for the LHA-1 Class.

The limited available historical data for the LHA-1 Class were considered insufficient to support a valid determination of overall class material condition. The identified maintenance-critical EICs all have a direct effect on the ship's ability to perform its mission. Preliminary indications are that there is serious degradation in these systems; however, comparisons should be made with additional data from other ships of the class before a final determination of class material condition is made. This approach will not only improve the data sample size, but will also provide a truer class representation with less predominance of the data by lead ship experience. A review of the class modernization plans indicates that a number of alterations have been developed and others are being contemplated to solve some of the major maintenance problems. None of the critical EIC equipments are scheduled for replacement; however, several major configuration changes are being contemplated that could affect the critical-EIC analyses.

3.2 DEFINITION OF PRELIMINARY PEOC PROGRAM MAINTENANCE STRATEGY

The data related to identified critical EICs and PFMs were reviewed in detail to evaluate the effects of revising the various elements (Level of Repair, Method of Repair, Timing of Repair/Operating Cycle) of maintenance strategy.

Satisfaction of the program objectives required that class availability be at least maintained with improvements highly desirable. The preliminary PEOC maintenance strategy must, therefore, be defined with full consideration of associated operational requirements and their effects.

Current operational and overhaul schedules provide a reference framework to use in considering possible scheduling revisions within the PEOC maintenance strategies. Considerable planning has been done and scheduling relationships are defined within TYCOM scheduling templates. Therefore, this study concluded that it was highly desirable to use existing scheduling templates while maintaining or reducing ship's time devoted to pre-overhaul, ROH, and post-overhaul activities. An optimum method of achieving both of these aims was to consider a formulation of cycles containing increased numbers of deployments. Possible alternatives consisting of 3, 4, and 5 deployments were considered and a three-deployment cycle seemed justified by existing data.

It should be noted that the maintenance strategies developed during the Initiation Phase are preliminary. Final definition of PEOC maintenance strategies will occur in the Development Phase after results of detailed engineering analysis have been obtained. The preliminary PEOC maintenance strategies are accurate and in enough detail to permit a valid comparison of the relative effectiveness and resource requirements of the current and preliminary PEOC maintenance strategies.

3.2.1 Summary of PEOC Maintenance Strategies

The proposed maintenance strategy for the classes of the PEOC Program retains much of the current strategy and is designed to blend with the current notional operating cycles in order to create the least amount of disruption to the Fleet and Type Commander during implementation. The emphasis of the proposed strategy is to provide an organization capable of accomplishing, evaluating, and up-dating the reliability-centered maintenance requirements for each ship class throughout the operating cycle. These requirements will be initially determined by system maintenance analyses (SMAs) performed during the Development Phase of the PEOC Program. The key elements of the proposed strategy, which is designed to support a three-deployment operating cycle, are:

- Increased use of off-ship maintenance management. A main thrust of the PEOC Program is the engineered approach to identify and meet the maintenance requirements for the LST-1179, LPD-4, and LHA-1 classes. The in-depth detailed engineering analyses conducted during the Development Phase, the System Maintenance Analyses, provide the tool to develop this engineered program of maintenance. This effort adds considerably to the knowledge and understanding of the class maintenance requirements while providing adequate planning and engineering information to permit more cost-effective use of additional off-ship (as well as shipboard) maintenance resources.

- The establishment of a PEOC Program functional organization to provide for the effective planning, coordination, evaluation, updating, and continuity of the PEOC maintenance strategy. This organization will include the following:

  - PEOC Program Office
  - Dedicated PEOC TYCOM Staff Elements
  - PEOC Central Technical Group
  - PEOC Site Teams

- A pre-EOC overhaul, of approximately 10 to 12 months duration, to realize an early improvement in ship material condition, and to facilitate structured planning and accomplishment of class maintenance.

- The use of a Selected Restricted Availability or planned industrial maintenance period of approximately six weeks duration between the ship deployments for the accomplishment of required maintenance on critical systems and limited alterations. These periods are necessary to prevent the maintenance burden on the maintenance-critical systems from building to the point where the material condition and availability of the ships is degraded.

- Modification of current two-deployment operating cycles to three-deployment cycles. The improvements in class material condition resulting from more cost-effective use of shipboard and off-ship maintenance resources enables these ships to include a third deployment within the operating cycle. This step significantly improves class operational availability and permits better realization of the potential benefits available from increased utilization of off-ship maintenance management.

The combined effect of these elements is improved material condition combined with increased operational availability for the LST-1179, LPD-4, and LHA-1 classes.

3.3 COMPARATIVE ANALYSIS BETWEEN CURRENT STRATEGY AND PRELIMINARY PEOC STRATEGY

3.3.1 Effectiveness Comparison

Two interrelated measures of availability were used to quantify the effectiveness of maintenance strategies; ship availability and Ships Available for Operation (SAFO). Ship availability is that fraction of the overall cycle a ship is either fully or substantially ready to perform its primary mission. SAFO describes the total number of ships of a class that may be expected to be operational at any given time.

Table 3-2 compares availability and SAFO resulting from the current strategy and projected PEOC Program and shows the percent of increases predicted for the projected PEOC Program. For purposes of this study, the 20-year period of comparison commences on completion of overhaul (regular or pre-EOC). Table 3-2 indicates that both availability and SAFO will increase in effectiveness, with the LHA-1 Class showing the greatest improvement in both categories.

Table 3-2. EFFECTIVENESS COMPARISON

Availability				Ships Available for Operation			
Class	Current	Projected PEOC Program	Percent Increase	Number of Ships in Class	Current	Projected PEOC Program	Percent Increase
LST-1179	0.651	0.695	6.8	20	13.0	13.9	6.9
LPD-4	0.623	0.669	7.4	12	7.5	8.0	6.7
LHA-1	0.584	0.633	8.4	5	2.9	3.2	10.3

3.3.2 Resource Comparison

Study results show that ship availability increases under the PEOC Program with an attendant slight increase in support cost. A comparison of the current and the PEOC Program resource requirements on the basis of two measures that combine availability and cost was made. The first measure is the cost to support a SAFO over 20 years. Table 3-3 shows that under the preliminary PEOC maintenance strategies, the cost to support a SAFO over 20 years is essentially unchanged for the LST-1179 Class, and decreases by 10.2 percent for the LPD-4 Class, and 6.0 percent for the LHA-1 Class. For the same period, total cost increased by 7.3 percent for the LST-1179 Class, 3.8 percent for the LHA-1 Class, but decreased by 4.3 percent for the LPD-4 Class.

Table 3-3. COST TO SUPPORT A SHIP AVAILABLE FOR OPERATION

Ship Class	Unit 20-year Support Cost (Millions of Dollars)	Class 20-year Support Cost (Millions of Dollars)	Ships Available For Operation (SAFO)	20-Year Support Cost Per SAFO (Millions of Dollars)
LST-1179				
Current	57.7	1,153.2	13.0	88.7
PEOC Program	61.8	1,237.3	13.9	89.0
LPD-4				
Current	89.2	1,070.4	7.5	142.7
PEOC Program	85.4	1,024.8	8.0	128.1
LHA-1				
Current	172.0	860.0	2.9	296.6
PEOC Program	178.5	892.7	3.2	279.0

The second measure, which also combines cost and availability, is the cost to obtain an equivalent SAFO as projected for the PEOC Program. Table 3-4 shows the additional costs, under the current strategy, of delivering an equivalent SAFO to that calculated for the projected PEOC Program. Navy Resource Model (NARM) FY 1979 values were used to obtain 20-year direct operating costs per ship, and the historical average acquisition cost for each class was inflated to FY 1979 dollars to obtain the assumed construction costs per ship.

Table 3-4. COST OF OBTAINING ADDITIONAL SHIPS AVAILABLE FOR OPERATIONS (SAFO) UNDER CURRENT STRATEGY

Class	Additional Ships Available For Operations Under PEOC Program	(a) New Ships Needed	(b) 20-Year Direct Operating Cost/Ship* (Millions of Dollars)	(c) Assumed Construction Cost/Ship (Millions of Dollars)	TOTAL = (a) (b + c) (Millions of Dollars)
LST-1179	0.9	1.4	108.0	54.1	226.9
LPD-4	0.5	0.8	182.0	86.8	215.0
LHA-1	0.3	0.5	334.0	562.4	448.2

*Excluding fuel costs.

Table 3-5 presents the results of direct cost comparison for all three classes. Cost savings under the PEOC Program are accompanied by specific and general improvements in class material condition resulting from pre-EOC overhauls and increased engineered maintenance of class requirements. The identification and planning of maintenance to reduce and prevent degraded material condition will produce a higher material readiness condition for these classes than is currently being experienced. More frequent access to depot level repair facilities under the PEOC Program not only permits closer scheduling of class maintenance requirements, but also permits more rapid correction of significant emergent repair needs.

Table 3-5. TOTAL COSTS TO OBTAIN AND PROVIDE EQUIVALENT SAFO

Ship Class	SAFO (Total)	Basic 20-Year Support Cost (Millions of Dollars)	Added Costs for Equivalent SAFO (Millions of Dollars)	Total Cost for Equivalent SAFO (Millions of Dollars)	PEOC Program Savings (Millions of Dollars)
LST-1179					
Current	13.9	1,153.2	226.9	1,380.1	-----
PEOC Program	13.9	1,237.3	-----	1,237.3	142.8
LPD-4					
Current	8.0	1,070.4	215.0	1,285.4	-----
PEOC Program	8.0	1,024.8	-----	1,024.8	260.6
LHA-1					
Current	3.2	860.0	448.2	1,308.2	-----
PEOC Program	3.2	892.7	-----	892.7	415.5

3.3.3 PEOC Program Feasibility

The comparison of the effectiveness and resource requirements of the current and preliminary PEOC maintenance strategies shows that the preliminary PEOC maintenance strategies provide better than 7 percent improvement in overall availability and SAFO values. The cost to obtain and support equivalent SAFO values under the current strategy totals $818.9 million more than comparable costs using the preliminary PEOC maintenance strategies. These gains are achieved from 3-deployment preliminary PEOC strategies and would, of course, improve even more should detailed engineering analysis support a greater number of deployments per cycle.

The engineered maintenance of the PEOC Program produces this increased availability over a 20-year period with an improved material condition resulting initially from the pre-EOC overhauls, and throughout this period from data analysis and engineering analysis to improve the identification and scheduling of class requirements.

The additional costs of $70.6 million above current maintenance strategy requirements over the 20-year period will produce appreciable gains in availability and material condition over the remaining life of these ships.

The results of this study indicate that the preliminary PEOC Program maintenance strategies are feasible and that they are more effective and economical than the current maintenance strategies.

3.4 PEOC PROGRAM DEVELOPMENT

In order to realize the benefits of the PEOC Program, a number of planning and engineering efforts are required during the development of the program.

3.4.1 Engineering Requirements

Upon approval of the preliminary PEOC maintenance strategy, the necessary engineering studies, maintenance plans, material condition assessment procedures, and evaluation processes required to convert this strategy into a viable program must be determined. These studies and analyses will result in documents that detail the steps for the effective development and implementation of the PEOC Program.

The engineering studies, schedules, and evaluation processes required to be developed for the PEOC Program are:

- Critical Equipments/Systems List
- Projected Class Configuration
- System Maintenance Analyses (SMAs)
- Pre-EOC Overhaul Requirements
- Class Maintenance and Modernization Plans
- Material Condition Assessment (MCA) Procedures
- Post-Overhaul Analysis Program
- Program Effectiveness Procedures

3.4.2 Planning Requirements

The guidance necessary for the execution of the PEOC Program is provided by the managers of the program and their support organizations. Planning for the program is documented in a Management Plan and in a PEOC Program Plan.

The Management Plan provides the primary program guidance by specifying the program objectives, the responsible organizations, and the process by which the program will develop and be implemented. The PEOC Program Office, administers primary guidance in the development and implementation of the program through the management plan. Fleet support and coordination is provided by TYCOM staff elements, field Site Teams, and a Central Technical Group.

The PEOC Program Plan is the program master plan which contains several Development Phase documents, including the Program Management Plan, to be used during the implementation of the program. Additionally the PEOC Program Plan serves to guide the transition of the program from the Development to the Implementation Phase.

3.4.3 Resource Requirements

The resources required to develop and implement the PEOC Program were estimated in order to provide the information required for preparation of POM inputs. Program personnel requirements were identified and summarized by organization. Organizational support costs were then estimated and summarized to determine the program development and implementation costs.

Table 3-6 presents a preliminary PEOC Program FYDP Planning Budget.

3.4.4 Milestones and Schedule

The milestones for initiating, developing, and implementing the Amphibious Engineered Operating Cycle Program are presented in Table 3-7 with the proposed dates for their commencement or completion.

These milestones contain a phased schedule for developing and implementing the PEOC Program on a class basis. This phasing spreads out the engineering workload for the program and facilitates the completion of detailed engineering analyses prior to Pre-EOC overhauls.

Table 3-6. PEOC PROGRAM FYDP PLANNING BUDGET
(THOUSANDS OF DOLLARS)

Organizational Elements/Budget Line Items	FY 1978	FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984
1. PEOC Program Office							
a. Civilian Salaries	152	266	266	418	418	418	418
b. Engineering Development	211	1,334	1,547	305	140	52	0
c. Engineering Support	-	-	250	272	308	306	158
d. Travel	8	15	16	23	23	23	23
e. Training and Professional Development (PEOC sponsored)	6	11	11	16	16	16	16
f. Test equipment (OPN) Purchase	-	-	4	6	8	8	8
g. Miscellaneous Support (copies, etc.)	-	-	4	4	8	8	8
2. PEOC Central Technical Group							
a. Civilian Salaries	-	-	-	304	304	304	304
b. Travel	-	-	-	14	14	14	14
c. Training and Professional Development (PEOC sponsored)	-	-	-	10	10	10	10
d. Vibration Program (Analysis and Support)	-	-	-	40	50	50	60
e. PEOC R&D Studies (Improved Test Techniques, etc.)	-	-	-	30	40	40	50
f. ADP/Miscellaneous Support	-	-	-	100	60	60	70
3. PEOC TYCOM Staff Elements Travel (Figure includes both TYCOMS)	-	-	2	5	7	7	7
4. PEOC Field Site Teams (Figures includes all three teams)							
a. Travel				36	94	124	132
b. Training				22	35	40	40
c. Test Equipment Calibration/Refurbishment				3	6	12	12
d. Miscellaneous Support				3	6	6	6
5. Milpers							
a. Officer	12	36	72	156	216	216	216
b. Enlisted				90	246	336	360
Totals -	389	1,662	2,172	1,859	2,009	2,050	1,912

Table 3-7. PEOC Program Milestones

1.	Start program Initiation Phase.	1 Oct 77
2.	Start program initiation study.	1 Oct 77
3.	Complete program initiation study	1 Jun 78
4.	Start NAVSEA/OPNAV review of program initiation study.	1 Jun 78
5.	Start development of critical equipments/systems list for LHA-1 Class.	1 Jun 78
6.	Start development of projected class configuration for LHA-1 Class.	1 Jun 78
7.	Start engineering analysis of critical systems for LHA-1 Class.	1 Jun 78
8.	Start program Development Phase for LHA-1 Class.	1 Jun 78
9.	Start development of critical equipments/systems list for LST-1179 Class.	1 Jun 78
10.	Start development of projected class configuration for LST-1179 Class.	1 Jun 78
11.	Complete development of critical equipments/systems list for LHA-1 Class.	1 Oct 78
12.	Complete development of projected class configuration for LHA-1 Class.	1 Oct 78
13.	Complete development of critical equipments/systems list for LST-1179 Class.	1 Oct 78
14.	Complete development of projected class configuration for LHA-1 Class.	1 Oct 78
15.	Complete program Initiation Phase.	1 Oct 78
16.	Enter resource requirements in Navy POM.	1 Oct 78
17.	Complete initiation study review. Establish Amphibious EOC Program.	1 Oct 78
18.	Start program Development Phase for LST-1179 Class.	1 Oct 78
19.	Start development of BOH SARP for LST-1179 Class.	1 Oct 78
20.	Start engineering analysis of critical systems for LST-1179 Class.	1 Oct 78
21.	Start development of class maintenance plan for LHA-1 Class.	1 Oct 78
22.	Start development of class maintenance plan for LST-1179 Class.	1 Oct 78
23.	Start development of program mangement plan.	1 Oct 78
24.	Start development of critical equipments/systems list for LPD-4 Class.	1 Oct 78
25.	Start development of projected class configuration for LPD-4 Class.	1 Oct 78
26.	Complete development of critical equipments/systems list for LPD-4 Class.	1 Apr 79
27.	Complete development of projected class configuration for LPD-4 Class.	1 Apr 79
28.	Start program Development Phase for LPD-4 Class.	1 Apr 79
29.	Complete preliminary class BOH requirements for LST-1179 Class.	1 Apr 79
30.	Start development of BOH SARP for LPD-4 Class.	1 Apr 79
31.	Start engineering analysis of critical systems for LPD-4 Class.	1 Apr 79
32.	Start development of class maintenance plan for LPD-4 Class.	1 Apr 79
33.	Start development of ship class material condition baseline and material condition monitoring/assessment procedures for LHA-1 Class.	1 Apr 79
34.	Start development of ship class material condition baseline and material condition monitoring/assessment procedures for LST-1179 Class.	1 Apr 79
35.	Start BOH planning (A-18) for LHA-1 Class.	1 Apr 79
36.	Start BOH planning (A-18) for LST-1179 Class.	1 Apr 79
37.	Start development of program effectiveness assessment procedures.	1 Jul 79

(continued)

Table 3-7. (continued)		
38.	Complete preliminary program management plan	1 Aug 79
39.	Complete preliminary class BOH requirements for LPD-4 Class.	1 Oct 79
40.	Complete preliminary class maintenance plan for LHA-1 Class.	1 Oct 79
41.	Complete preliminary class maintenance plan for LST-1179 Class.	1 Oct 79
42.	Start development of Management Information System (MIS).	1 Oct 79
43.	Start development of ship class material condition baseline and material condition monitoring/assessment procedures for LPD-4 Class.	1 Oct 79
44.	Start BOH planning (A-18) for LPD-4 Class.	1 Oct 79
45.	Complete proposed SARP for first ship BOH for LST-1179 Class.	1 Jan 80
46.	Complete preliminary class maintenance plan for LPD-4 Class.	1 Apr 80
47.	Complete proposed SARP for first ship BOH for LPD-4 Class.	1 Jul 80
48.	Complete program management plan.	1 Aug 80
49.	Complete engineering analysis of critical systems for LHA-1 Class.	1 Oct 80
50.	Complete engineering analysis of critical systems for LST-1179 Class.	1 Oct 80
51.	Complete ship class material condition baseline and material condition monitoring/assessment procedures for LHA-1 Class.	1 Oct 80
52.	Complete ship class material condition baseline and material condition monitoring/assessment procedures for LST-1179 Class.	1 Oct 80
53.	Complete program effectiveness assessment procedures.	1 Oct 80
54.	Start implementation of program engineered maintenance management system.	1 Oct 80
55.	Start first LHA-1 Class ROH	1 Oct 80
56.	Start first LST-1179 Class BOH.	1 Oct 80
57.	Complete class maintenance plan for LHA-1 Class.	1 Jan 81
58.	Complete class maintenance plan for LST-1179 Class.	1 Jan 81
59.	Complete program Development Phase for LHA-1 Class.	1 Jan 81
60.	Complete program Development Phase for LST-1179 Class.	1 Jan 81
61.	Start program to translate class plans into individual ship plans.	1 Jan 81
62.	Complete MIS Development	1 Jan 81
63.	Establish Central Technical Group.	1 Jan 81
64.	Establish Site Teams.	1 Jan 81
65.	Complete program Development Phase for LPD-4 Class.	1 Apr 81
66.	Start first LPD-4 Class BOH.	1 Apr 81
67.	Complete engineering analysis of critical systems for LPD-4 Class.	1 Apr 81
68.	Enter CMMP items into MIS.	1 Apr 81
69.	Complete ship class material condition baseline and material condition monitoring/assessment procedures for LPD-4 Class.	1 Apr 81
70.	Complete program to translate class plans into individual ship plans for first ships to enter PEOC.	1 Apr 81
71.	Complete class maintenance plan for LPD-4 Class.	1 Jul 81
72.	Complete first LHA-1 Class ROH; ship enters EOC.	1 Sep 81
73.	Complete first LST-1179 Class BOH; ship enters EOC.	1 Sep 81
74.	Complete first LPD-4 Class BOH; ship enters EOC.	1 Mar 82

SECTION FOUR

CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

Conclusions drawn from the analyses conducted during the Amphibious Engineered Operating Cycle Initiation Study were based on maintenance data and other data sources identified in the study. Ample historical data existed (and were used) for the LST-1179 and LPD-4 classes, but design data was used to augment LHA-1 class historical data because of limited operating experience for this class. The conclusions of this study are based on the average experience of the individual ships of each ship class investigated.

The following conclusions were reached as a result of this study:

- Adoption of a revised maintenance strategy for the proposed classes of amphibious ships will assist in maintaining their combat readiness at an acceptable cost and will maintain or increase their peacetime operational availability.
- Maintenance-critical systems were identified with a high degree of correlation among all the material condition indicators investigated. These identified maintenance-critical systems have underscored the need for revised or alternative long-range class maintenance strategies for the LST-1179, LPD-4, and LHA-1 classes of amphibious ships.
- Analyses of maintenance-critical systems reveal the desirability of revisions to the Timing of Repair and the Operating Cycle elements of maintenance strategy to offer the highest potential for improving maintenance strategy.
- Early improvement in material condition can best be obtained through a pre-EOC overhaul. The pre-EOC overhaul should be considered a prerequisite for a ship's entering an Engineered Operating Cycle.

- Ships in the PEOC Program will maintain an improved level of material condition. Planned actions to provide this improvement include:

  - Continuing identification, analyses and monitoring of maintenance and mission critical equipments in order to plan and correct problems prior to failure or unacceptable degradation.
  - Scheduling of required maintenance, based on class as well as individual ship experience and trends.
  - Shorter intervals between scheduled depot availabilities for ships because SRAs are planned between overhauls. This allows correction of major problems earlier.
  - Strong emphasis on the completion of reliability and maintainability alterations, initially during the pre-EOC overhaul, and as they are identified during the operating cycle.

- The preliminary PEOC Program maintenance strategies for the LST-1179, LPD-4, and LHA-1 classes call for maintenance performed on a periodic (or scheduled) basis. The most effective operational cycle is one with 3-deployments per cycle, with two six-week Selected Restricted Availabilities per cycle.

- The preliminary PEOC maintenance strategies are projected to provide the following benefits over a 20-year period. These benefits are in addition to an appreciable improvement in material condition.

Class	Increase in Availability (Percent	Increase in Ships Available for Operation (Percent)	Increase in Total Cost (Percent)	Savings for Equivalent SAFO (Millions)
LHA-1	8.4	10.3	3.8	415.5
LPD-4	7.4	6.7	(4.3)*	260.6
LST-1179	6.8	6.9	7.3	142.8

*( ) shows a decrease in cost.

- The PEOC Program for the LST-1179, LPD-4 and LHA-1 classes of ships is feasible and projected to be both operationally and cost effective. The benefits of the program are greatest for the LHA-1 Class and nearly equivalent for the LPD-4 Class. LST-1179 Class cost benefits are less, however, the material condition improvements are appreciable.

4.2 RECOMMENDATIONS

On the basis of the study conclusions, the following recommendations are offered:

- Develop and implement the PEOC Program for the LHA-1, LPD-4 and LST-1179 classes of amphibious ships in general accordance with the results of this study. A *Plan of Action and Milestones* is a part of this study.
- Establish as the initial goal of the PEOC Program, three deployments between shipyard overhauls for all three classes. However, during the Development Phase of the program, an analysis should be conducted to investigate further extension of the cycle to include four deployments.